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1975

SNAGS, PARTLY DEAD, & DEFORMED TREES

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SNAGS, PARTLY DEAD AND DEFORMED TREES

Snags are standing dead trees. However, there is a continuum from live vigorous trees to soft, dead trees. Some live trees contain decay or have hollow centers, dead tops or limbs and some trees have only a few live branches. Trees are used by different wildlife species and for varied reasons throughout this continuum. These "wildlife" trees play a role in the forest community and their use needs to be understood for multiple use management.

During the summers of 1974 and 1975, a portion of our time was spent in obtaining information on the role trees in the continuum play in the forest community. Our findings are presented in this section for consideration in future management prescriptions for the Umatilla National Forest and hopefully, for reference by resource managers in other forests as well.

CAVITY NESTING

Nests were found during the course of our daily work with no deliberate search. Most nests were found by the behavior of a bird, by observing a bird enter or leave a cavity hole or by vocalization of the young. Therefore, the nests in our sample are not biased by a predetermined search image or configuration of nest trees as would be the case if we actively searched for nests.

Seventy-seven cavity nests were found in the three northern districts of the Umatilla National Forest, 28 in 1974 and 49 in 1975. Also included in some of the tabulations are 27 cavity nests from the three southern districts of the forest, 14 located by Greg Green in Ukiah-Heppner Districts and 13 by Rex Baxter in the Dale District in 1974. Both Green and Baxter spent some time with us early in the 1974 nesting season to discuss our respective field studies and methods of obtaining comparable data.

Information recorded on cavity nests included bird species, nest tree species, measurements and habitat. At 20 cavity nest sites of cavity excavators (primary cavity nesters) we collected additional information from the five closest snags or in some cases less than five insites of very low snag density. Dead trees six feet or taller and at least nine inches dbh at nests of red-breasted nuthatches, hairy woodpeckers, black-backed and northern 3-toed woodpeckers and at least 12 inches dbh at nests of flickers and Williamson's sapsuckers were counted. Measurements included distance from nest tree, dbh and height. The species of each snag was recorded. Snags were listed as broken topped or entire. The five closest snags to the nest tree will be referred to as adjacent snags and the twenty nest tree sample will be referred to as nest tree (20) (Table 1).

TABLE 1

Comparison of number of nests by bird species in nest trees (20) category and number of nests for each species of cavity nester found.

Excavator Species	No. of Nests	No. in Nest Trees (20) Category
Flicker	15	10
Lewis Woodpecker	1	
Yellow-bellied Sapsucker	1	
Williamson's Sapsucker	6	3
Hairy Woodpecker	7	3
Black-backed 3-toed Woodpecker	2	1
Northern 3-toed Woodpecker	2	1
Red-breasted Nuthatch	5	2
	39	20

Dead, Partly Dead and Live Trees

Nest trees were listed as partly dead if there was a dead top or with dead and/or dying branches. Live trees included trees with hollow and decayed centers.

Thirty percent of the nests were in trees that were not dead (Table 2). A high proportion of tamarack nest trees were alive. Live nest trees were all smaller than 26 inches dbh (Table 3) and in the middle height ranges (Table 4). They all contained decayed heartwood. Baxter found nests in two live trees greater than 100 feet; these were lodgepoles 11 and 12 dbh.

TABLE 2

Distribution of 77 cavity nests found according to tree species and condition.

Species of Tree	Dead Tree	Partly Dead Tree	Live Tree	Total	% Of Grand Total
1974 and 1975					
Ponderosa Pine	22	4	2	28	36
Douglas-fir	18	3	1	22	29
Grand Fir	9	3		12	16
Tamarack	3	3	5	11	14
Subalpine Fir	1		1	2	3
Englemann Spruce	1			1	1
Aspen	—	1	—	1	1
TOTAL	54	14	9	77	
% OF GRAND TOTAL	70	18	12		

TABLE 3

Distribution of active cavity nests found according to dbh and condition of nest tree - 1974 and 1975.

Class of Tree (")	Dead Tree	Partly Dead Tree	Live Tree	Total	% Of Grand Total
< 10 *	5	1	1	7	9
10-19	24	4	5	33	43
20-29	15	3	3	21	27
30-39	7	3		10	13
40-49	2	3		5	6
> 49	1			1	1
				77	

* Smallest, 6 inches

TABLE 4

Distribution of active cavity nests found according to tree height classes - 1974 and 1975.

Height Class of Trees(')	Dead Tree	Partly Dead Tree	Live Tree	Total	% Of Grand Total
< 10 *	6			6	8
10-19	13			13	17
20-29	14	3		17	22
30-39	9		1	10	13
40-49	6	1		7	9
50-59	2		3	5	6
60-69	1	1	3	5	6
70-79	1	6	2	9	12
80-89	1	2		3	4
90-99		1		1	1
> 99	1			1	1
TOTAL	54	14	9	77	

* Smallest, 6.7 feet

Sparrow hawks and red-breasted nuthatches nested only in dead trees; flickers and mountain bluebirds used a preponderance of dead trees while the hairy woodpeckers used mostly live trees. Two northern 3-toed woodpecker nests were in live trees and two black-backed 3-toed woodpecker nests were in dead trees, one of which had recently died. Three of the four 3-toed nest trees had one or more Echinodontium tinctorium conks.

Nest trees were organized into categories according to the most noticeable defect (Table 5). All but one of these trees had at least one visible defect. Some nest trees listed in Table 5 also showed lightning scars, cracks and conks but a complete record was not kept. Some broken top and dead top nest trees had one or more new leaders. Some dead top trees also had broken tops but were only listed in the dead top category. Therefore, greater than 72 percent of the nests were in broken-top trees. Ninety-one percent of the nests in dead trees were in broken-top trees. A comparison was made between percent of broken tops in adjacent snags and in nest trees which were dead (Table 6). The data indicated that broken tops were preferred. Ponderosa pine and Douglas-fir showed a greater proportion of broken tops in the adjacent snags than grand fir and tamarack. Five sub-alpine fir snags had broken tops but all were in one stand and no conclusions can be considered from this single sample.

TABLE 5

Most noticeable defect of 75 cavity nest trees observed 1974 and 1975 in percent of total. **

Broken Top		Dead Top	Ponderosa Pine Flat Top		Echinodontium tinctorium Conk Subalpine Fir and Grand Fir***	Live Tamarack W/Clustered Branches	None of Others *
Dead Tree	Live Tree		Dead Tree	Live Tree			
64	8	11	1	3	4	5	4

* Crack, double leader, no obvious defect

** Lightning strike scars also present on some

*** All 3-toed woodpecker nests

TABLE 6

Top condition of cavity nest snags and adjacent snags according to tree species.

	Nest Snags		Adjacent Snags	
	% Broken Top	Sample Size	% Broken Top	Sample Size
Ponderosa pine	91	22	65	23
Douglas fir	94	17	69	26
Grand fir	78	9	37	30
Tamarack	100	3	25	4
Subalpine fir	100	1	100	5
Lodgepole pine	-	0	0	2
Spruce	100	1	100	2
	91	53	57	92

Species of Tree

Most cavity nests were found in ponderosa pine and Douglas-fir (Table 2 and 7). As a test of desirability, the number of adjacent snags of each tree species was compared with the number of nests in each tree species (Table 8). The results showed a selection by the birds. This comparative procedure, however, would tend to discriminate against the nest tree species which was not included with the adjacent snag calculations. Inclusion of nest trees with adjacent snags still showed a selection of birds. Using all 20 nest trees in which adjacent snags were recorded, ponderosa pine was selected for, with grand fir and Douglas-fir selected against as cavity nest species.

Selection of tree species by two different cavity nest species is shown in Tables 9 and 10. A comparison of Tables 7, 9, 10 and 11 provides a broader picture of tree species selection. Flickers selected for ponderosa pine, against Douglas-fir and used grand fir in relation to relative abundance. Williamson sapsuckers reflected a use of what was available and perhaps a selection against grand fir. Red-breasted nuthatches nested in a variety of habitats but used Douglas-fir four out of five times. The one use of grand fir was in a site severely defoliated by Tussock Moths and with no Douglas-fir.

TABLE 7

Distribution of cavity nests by bird species according to tree species and condition - 1974 and 1975.

	Tree Species								Condition of Tree		
Bird Species	Pond. Pine	Doug. Fir	Tamarack	Grand Fir	Spruce	Sub-alpine Fir	Aspen	Total	Dead	Partly Dead	Live
Sparrow Hawk	3	1						4	4		
Common Flicker	8	4	1	2				15	13	1	1
Lewis Woodpecker	1							1	1		
Yellow-bellied Sapsucker				1				1	1		
Wm. Sapsucker	2	4						6	4	2	
Hairy Woodpecker		1	3	2			1	7	1	4	2
Black-backed 3-toed W.P.				2				2	2		
N. 3-toed Woodpecker				1		1		2		1	1
Black-capped Chickadee			2					2			2
Mountain Chickadee	1	3	1	1				6	3	1	2
Red-breasted Nuthatch		4		1				5	5		
Western Bluebird	5	2	1					8	5	3	
Mountain Bluebird	8	3	3	2	1	1		18	15	2	1

TABLE 8

Percent of tree species selected by cavity nesters compared with snags available within 300 feet of nest tree.

Tree Species	Percent Nests	Percent Adjacent Snags	Percent Adjacent Snags Plus Nest Trees
	(n=20)	(n=92) *	(n=112) *
Ponderosa pine	35	22	24
Douglas fir	25	32	30
Grand fir	20	34	31
Tamarack	10 **	4	5
Subalpine fir	5 **	5	5
Spruce	0	2	2
Aspen	5 **	0	1
Lodgepole pine	0	1	1

* Distribution significantly different from nest species distribution at .01 level. (df 4)

** Live trees

TABLE 9

Percent of tree species selected by flickers compared with snags available within 300 feet of nest tree.

Tree Species	% Nests	% Adjacent Snags	% Adjacent Snags Plus Nest Trees
	(n=10)	(n=44)	(n=54)
Ponderosa pine	60	34	37
Douglas fir	20	39	37
Grand fir	20	23	22
Spruce	0	5	4

TABLE 10

Percent of tree species selected by Williamson's sapsuckers compared with snags available within 300 feet of nest tree

Tree Species	% Nests	% Adjacent Snags	% Adjacent Snags Plus Nest Trees
	(n=3)	(n=15)	(n=18)
Ponderosa pine	33	27	28
Douglas fir	67	60	61
Grand fir	0	13	11

TABLE 11

Number of nest trees by species in each habitat type.

Cavity Nest Species	Total Nests in Each Habitat Type: Ponderosa Pine Type	Mixed Conifer Type	Subalpine fir Type	Total Nests in Each Tree Species: Pond. Pine	Doug. fir	Grand fir	Tamarack	Sub-alpine fir	Spruce	Aspen
Sparrow hawk	4			3	1					
Flicker	8			6	2					
		7		2	2	2	1			
Lewis Woodpecker	1			1						
Yellowbellied Sapsucker		1				1				
Williamson's Sapsucker	5			2	3					
		1				1				
Hairy Woodpecker		7			1	2	3			1
Black-backed 3-toed		2				2				
Mountain Chickadee	3			1	2					
		3			1	1	1			
Red breasted Nuthatch	2				2					
		3			2	1				
Western Bluebird	7			5	2					
		1					1			
Mountain Bluebird	9			7	2					
Percent of each tree species used in a habitat type										
Habitat Type										
Pond. Pine				64	36					
Mixed Conifer or Grand fir				10	26	39	19	3		3
Sub-alpine fir							72	14	14	

DBH*

DBH of 77 nest trees ranged from six to 54 inches with a mean of 21.5 (Tables 3 and 12). The mean dbh of 77 nest trees reported by Anderson (1974) was 21 inches. Ponderosa pine nest trees were generally larger than other species. There were no nests in grand fir with a dbh of 15 to 24 inches but larger and smaller grand firs were used. Among all 77 cavity nests, 58 (75%) were in trees greater than 12 inches dbh.

TABLE 12

Tree species and dbh size classes used by cavity nesters in 1974 and 1975 (n=77).

	DBH Size Classes (in.) 5-14	15-24	25-34	35-44	>44	Mean dbh	Range
Ponderosa pine	2	9	9	7	1	27.8	14-54
Douglas fir	4	14	3	1	0	18.8	10-38
Grand fir	7	0	2	3	0	21.1	6-41
Tamarack	10	1	0	0	0	11.8	7-21
Subalpine fir	2	0	0	0	0	10.0	8-12
Spruce	0	0	1	0	0	25.3	-
Aspen	1	0	0	0	0	12.0	-
Total	26	24	15	11	1	21.5	

Is there any relationship between dbh of the tree chosen and the number and size of trees available? A comparison of nest tree availability with use by dbh class is shown in Table 13. Size class five to 14 inches dbh was not included because of minimum size limits used on adjacent snags. This table dramatically shows selection for larger dbh trees. Compare the percent of available nest trees in the sample in each size to the percent of trees used in each class. For example, although 68% of the sample of available trees were 15-24" dbh, only 50% of that size were used and, while only 4% of the sample were 35-44", 25% of the nest trees (20) were in that tree size class.

TABLE 13

Percent of adjacent snags, nest trees and nest trees (20) in each of four dbh classes.

DBH (")	Nest Trees (20)	All Nest Trees	Adjacent Snags
	(n=12)	(n=51)	(n=75)
15-24	50	47	68
25-34	25	29	27
35-44	25	22	4
> 44	0	2	1

Table 14 shows the mean and range of dbh nest trees for each bird species. Some species nested in a broad spectrum of tree sizes. There appeared to be a relationship among smaller dbh trees nested in by each bird species and the available nesting trees (Table 15). Three cavity nests were found in fuel breaks with two in the smallest dbh trees recorded for that species. The third nest tree found in a fuel break was a mountain chickadee nest in a 16-inch dbh tree. Conner, et al (1975) in a study of woodpecker habitat in Virginia, found flickers were nesting in trees with a mean dbh of 14.5 inches (n=6) in clearcuts with few snags left and in trees with a mean dbh of 34.6 inches (n=16) in woodlots.

TABLE 14

DBH, Height of tree and height of cavity nest according to bird species,** 1974 & '75

	No. in sample	D.B.H. (") Range	Mean	Hgt of nest(') Range	Mean	Hgt of tree (') Range	Mean
Sparrow Hawk	3	24-37.6	30.0	17-34	25.5	23-35	31
Common Flicker	15	11.8-48.4	24.1	5-80	25.7	8-100	40
Lewis Woodpecker	1		25.8		12		18
Yellowbellied Sapsucker	1		40.5		27		33
Williamson's Sapsucker (6)*4		15.3-38.7	26.8	5-22	13.2	12-78	35
Hairy Woodpecker	7	7.1-30.8	17.0	7-60	28.6	21-83	63
Black-backed 3-toed w.p.	2	8.7-11.7	9.9	18-23	20.5	45-68	57
Northern 3-toed w.p.	2	8.3-11.9	10.1	15-16.5	15.8	48-50	49
Black-capped Chickadee	1		10.4		35	50	50
Mountain Chickadee	6	12.9-37.7	20.4	1.4-37	18.7	24-72	39
Red-breasted Nuthatch	5	6-23.6	14.9	15 4-30.0	21.8	16-41.4	27
Western Bluebird	7	13.5-38.7	20.6	5.3-70	27.6	6.7-80	42
Mountain Bluebird	16	8-32.5	19.7	3 9-72 5	24	7.6-90	33

* Sample size for height of nest

** A tree used two years by the same species was not counted twice except for

TABLE 15

Major characteristics of the nest site at cavity nests in small dbh trees for particular bird species and the next largest nest tree found.

Bird Species	dbh (")	Site Characteristics
Red-breasted nuthatch	6.0	Stand thinned and subsequently killed by tussock moths
(next largest dbh=18.0)		
Hairy woodpecker	7.1	Fuel break
(next largest dbh=10.7)		
Northern 3-toed woodpecker	8.1	Salvage cut and broadcast burn
(next largest dbh=11.9)		
Black-backed 3-toed woodpecker	8.7	Salvage cut
(next largest dbh=11.7)		
Flicker	11.8	Sparse ponderosa pine and Douglas-fir. Partially logged.
	13.7	Moist meadow, previously logged
(next largest dbh=16.0)		
Mountain chickadee	12.9	Fuel break
	14.0	Select cut
(next largest dbh=16.0)		
Mountain bluebird	8.0	Clear cut
	8.3	Clear cut, few trees left standing Low snag density earlier logging Sparse ponderosa pine and Douglas-fir. Partially logged
	11.4	Clear cut
(next largest dbh=13.5)		

Thirty percent of all nests were in recently disturbed sites. Table 15 shows that most nests found in very small dbh trees were in areas with low snag density. To further explore the relationship between the size of tree dbh chosen for nesting with number of snags, 20 nest snags were listed in order of mean distance of adjacent snags (Table 16). The mean dbh of the adjacent snags and dbh of the nest tree were compared. In general, nests at sites with a large number of snags were the same size or larger than adjacent snags. In locations where there was a lower number of snags, nest trees were smaller than adjacent snags. These data suggest that there is a relationship.

TABLE 16

Comparison of the dbh of 20 nest trees with the mean dbh of 5 adjacent snags.

Nest No.	Species	Estimated snags/acre	Adjacent Snags Ave. Dist.(')	Adjacent Snags Ave. dbh(")	Nest Trees dbh(")	Nest Tree dbh Compared With Ave. Adj. Snag dbh		Remarks
28	Flicker	100+	16	18.8	19	+		
57	Northern 3-toed w.p.	100+	16	10.7	11.9	+		
29	Flicker	17	23	19.6	26	+	**	
45	Nuthatch	18	47	14.8	23.6	+	**	
66	Williamson's sapsucker	14	61	24	32	+	*	
61	Black-backed 3-toed w.p.	8.5	66	15.5	8.7	-		Fire killed many trees previous fall
** 3	Flicker, ylw-bld sps.	5	74	17.4	40.5	+	**	
62	Flicker	3.5	83	26	37	+		
4	Hairy woodpecker	3.5	88	22.3	10.8	-	**	
25	Flicker	4	100	21.3	13.7	-	**	
26	Hairy woodpecker	3.5	103	30	11.5	-	*	
** 7	Williamson's sapsucker	3	108	23.7	15.3	-	**	
48	Northern 3-toed w.p.	2	128	16.8	8.3	-	**	
*** 8	Williamson's sapsucker	.8	142	25.7	38.7	+	**	Nest tree-lge tree w/many holes
56	Flicker	1.5	144	18.3	21.7	+	**	Nest tree-well weathered w/many holes
22	Flicker	1.5	>172	17.4	11.8	-	**	<5 adjacent snags counted
37	Hairy woodpecker	1	>178	14.2	7.1	-	<"	" " "
51	Flicker	.1	>187	26	20.3	-	<"	" " "
3-74	Flicker	1	219	23.8	23	-		
** 11	Flicker	.2	>262	21.2	25.4	+	<"	" " "

* t significant at .100
** t significant at .050
:* Double nest (nests 7, 8 and 11 with bluebird)

Number of Holes/Nest Tree

Birds make holes in trees for various purposes. It is sometimes impossible without close examination to tell if a hole is used for nesting and/or roosting, if the cavity construction was completed or abandoned, or if it is a feeding hole. Feeding sign and nesting or roosting holes may be present in the same tree. Trees with more than one apparent nest hole often had holes of different sizes indicating excavation by different species. Sapsuckers typically nest in trees with many sapsucker holes. Williamson's sapsuckers were the only excavating species besides chickadees we found using the same tree two consecutive years for nesting. These birds used new holes each year (Table 17). The number of holes were recorded for approximately half of the nest trees. In most cases, trees with multiple nest holes were at least 28 feet tall and often much taller. Active nest trees with five or more apparent nest holes included five ponderosa pines, one Douglas-fir and one grand fir with a mean height of 42 feet (22 to 77) and mean dbh of 33.5 inches (22 to 39). Multiple hole trees tend to be larger (Tables 18 and 19).

TABLE 17

Use and condition of nest trees in 1975 which contained active nests in 1974.

		Inactive				Active				
			Damaged		Down	Nest-	Same	Different	Same	Different
Species	Nest Number	Intact	Natural*	Human**	Fell Cut	ing	Hole	Hole	Species	Species
Sparrow hawk	58					X	X		X	
Common Flicker	3	X								
	21				X (Road construction)					
	36	X								
	40		X							
Williamson's sapsucker	18					X	X			X (Mt. Blue-bird)
								X	X	
	27		X							
	29					X	X			X (Western Bluebird)
	43					X		X	X	
								X		X (Western Bluebird)
Hairy woodpecker	26				X≠					
Northern 3-toed woodpecker	57	X								
Black-capped Chickadee	51					X	X		X	
Mountain Chickadee	22	X								
Red-breasted Nuthatch	28					X		X		X (Flicker)
	45	X								
	46	X								
	58	X								
Western Bluebird	8					X	X		X	
Mountain Bluebird	4		X							
	7					X	X		X	
	16	X								
	17	X								
	24	X								
	20	X								
	33	X								
	35	X								
	52					X	X		X	
	53			X≠						
	55				X (Used 1974-1975 winter by weasel & small rodent)					
		13	3	1	2 1	9	7	4	7	4

Loss of nest tree or previously used hole - 7/29 - 24%
Tree fell down 2/29 - 7%
Available trees for 1975 - 22
Re-used trees - 9/22 = 41%
Trees re-used by same species - 7/22 = 32%
Hole re-used by same species - 5/22 = 23%

Tree used by different species - 4/22 = 18%
Hole used by different species - 2/22 = 9%
* Large pieces of tree broken off. Holes that were present were unusable.
** Cut by axe all around hole.
≠ Small mammal used hole.

TABLE 18

Mean dbh of trees containing different numbers of nesting or roosting holes.

	Mean dbh of Nest Trees (in.)	
No. of Holes	Miller n=32	Anderson (1974) n=76
1	14	17
2 or 3	20	24
4 or more	36	28

TABLE 19

Mean height of trees containing different numbers of nesting or roosting holes.

No. of Holes	Mean Height of Nest Trees (feet) Miller n=32	Anderson (1974) n=77
1	23	33
2 or 3	34	46
4 or more	43	66

*DBH - Diameters listed include the bark. Ponderosa pine measurements on barkless trees were corrected by the formula: Bt = .627 + .108d derived from Bt = .5661 + .0976D where Bt = double bark thickness, D = tree diameter outside bark, d = diameter inside bark, then Bt + d = D

Nest Tree Height

Mean height of nest trees was 39 feet. Anderson (1974) reported a mean height of 40 feet for 77 nest trees. Distribution of tree heights can be seen in Table 4 and mean and range of heights used by each bird species can be seen in Table 14. No selection was apparent when mean nest tree heights were compared with mean adjacent snag heights arranged according to tree species (Table 20). The mean height of dead nest trees was lower reflecting selection for broken tops shown in Table 6.

When percent of tree height classes used are compared with two studies (Gale 1973 and Anderson 1974) and Table 4, similar patterns show up.

Height of Nest Tree (ft)	Gale (n=57)	Miller (n=77)	Anderson (n=76)
< 20	30%	25%	30%
20-49	40%	44%	38%
> 49	30%	31%	32%

Gale's data on height of sampled snags compared with height of nest snags show a selection for snags in the 20-40 foot size.

TABLE 20

Comparison of average height of cavity nest trees and nest snags with height of adjacent snags according to tree species.

	Nest Trees		Adjacent Snags		Nest Snags	
	No. Nests	Ave. Ht.(Ft.)	No. Snags	Ave. Ht.(Ft.)	No.Nests	Ave.Ht.(Ft
Ponderosa Pine	28	38	23	38	22	28
Douglas fir	22	29	26	35	18	26
Grand Fir	12	46	32	51	9	40
Tamarack	11	54	4	54	3	25

Height of Nests

Mean and range of heights of nests by bird species are shown on Table 14 and mean heights by tree species on Table 21. Mean heights reported by others are shown on Table 22. Mean nest heights found during our study are generally similar to those found in other studies.

TABLE 21

MEAN CAVITY NEST HEIGHT AND NEST TREE HEIGHT
ACCORDING TO TREE SPECIES

	No. Nests	$\bar{x}$ Nest Hgt (ft)	$\bar{x}$ Tree Hgt (ft)	Nest Hgt/Tree Hgt
Ponderosa Pine	28	24	38	.63
Douglas-fir	22	18	29	.62
Grand fir	12	29	46	.63
Tamarack	11	27	54	.50

TABLE 22

COMPARISON OF MEAN NEST HEIGHTS REPORTED BY SOME AUTHORS

	Miller		Lawrence 1967		Conner et. al.,1975		Jackman 1974, 1975		Baxter		Green	
Species	Mean nest height	No. of nests	Mean nest height	No. of nests	Mean nest height	No. of nests	Mean nest height	No. of nests	Mean nest height	No. of nests	Mean nest height	No. of nests
Flicker	26	15	23	25	28	6*			8.7	3	32	1
					45	16**						
Lewis Woodpecker	12	1										
Ylw-bld Sapsucker	17	1					28	19	11	1		
Wh. Sapsucker	13	6					38	13	18	1	40	3
Hairy Woodpecker	28	7	35	11	29	10	25	12	19	1	53	1
Bl-backed 3-toed	21	2					10	46	20	1		
Northern 3-toed	16	2					17	10	9	1		
Bl-cpd Chickadee	35	1										
Mountain Chickadee	19	6							18	3		
Red-brd Nuthatch	22	5									27	1
Western Bluebird	28	7							20			
Mountain Bluebird	24	16										

* Clearcuts
** Woodlots

nest height

Although the mean nest height varied in different tree species, the ratio tree height was consistent in three species (Table 21). The mean dbh for tamarack nest trees was 11.5 inches (Table 12) which was quite a bit smaller than other species of Table 21. Conner's (1975) 69 nests had a ratio of .64. The ratio for all our nests was .59. McClelland's (1974) paper birch nest trees (n=21) had a ratio of .78 and tamarack .75 (n=46). The ratio for both was .76. The mean dbh for tamarack was 27 inches and mean dbh for paper birch was 14 inches.

The entrance hole of 25 out of 77 nests (32%) was within two feet of the top of the tree. Twenty-four out of 54 (44%) nests in dead trees were in the top two feet. Some tree and bird species showed this pattern more frequently than others (Table 23). The mean height of these 25 trees was 22 feet compared to 39 feet for all nest trees.

TABLE 23

Distribution of Nests Within Two Feet of Top of Nest Tree

	Pond. Pine	Doug. Fir	Grand Fir	Tam	S.A. Fir	Eng. Spruce	Aspen	% of Nests of That Species
Sparrow Hawk		1						25
Cm. Flicker	3	2						33
Wm. Sapsucker		1						17
Hairy Woodpecker							1	14
Mt. Chickadee		1	1					33
Red-Br. Nuthatch		2						33
Western Bluebird	2	1						38
Mt. Bluebird	3	1	2	2	1	1		56
% of Total Nests Found in That Species	29	41	25	18	50	100	100	

Sapsuckers frequently use the same tree, new hole in subsequent years. With large trees there is room for many holes and the birds can follow the progress of decay in selecting a spot for excavating. A short snag does not provide this leeway. A Williamson's sapsucker nest was in a stub 12 feet high with a dbh of 15 inches in 1974. This hole was 10.5 feet high. The following year, the new hole was five feet high. Presumably, this was the best spot in relation to degree of decay. It was not the best spot in relation to predation. Feathers were found below the hole. The low nest hole height in 1975 probably made this nest more vulnerable.

Nest Location in Relation to Water

Three out of 64 cavity nest trees were within five chains of water. Most bodies of water in our sample did not support typical riparian nest tree species of aspen and cottonwood.

Amount of Bark on Nest Trees

Table 24 contains information on amount of bark on dead trees used for cavity nesting in relation to tree species.

Although the mean nest height varied in different tree species, the ratio $\frac{\text{nest height}}{\text{tree height}}$ was consistent in three species (Table 21). The mean dbh for tamarack nest trees was 11.5 inches (Table 12) which was quite a bit smaller than other species of Table 21. Conner's (1975) 69 nests had a ratio of .64. The ratio for all our nests was .59. McClelland's (1974) paper birch nest trees (n=21) had a ratio of .78 and tamarack .75 (n=46). The ratio for both was .76. The mean dbh for tamarack was 27 inches and mean dbh for paper birch was 14 inches.

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Gn. Flicker	3	2						33
Wn. Sapsucker		1						17
Hairy Woodpecker							1	14
Mt. Chickadee		1	1					33
Red-Br. Nuthatch		2						33
Western Bluebird	2	1						38
Mt. Bluebird	3	1	2	2	1	1		56
% of Total Nests Found in That Species	29	41	25	18	50	100	100	

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Nest Location in Relation to Water

Three out of 64 cavity nest trees were within five chains of water. Most bodies of water in our sample did not support typical riparian nest tree species such as aspen and cottonwood which are frequently used for cavitiy nesting. Other researchers have shown a substantial relationship between water and nest occurrence.

Amount of Bark on Nest Trees

Table 24 contains information on amount of bark on dead trees used for cavity nesting in relation to tree species.

TABLE 24

Amount of Bark on Dead Trees Containing Cavity Nests

Bark Category	Ponderosa Pine	Douglas-fir	Grand Fir	Tamarack
On-greater than 4/5 present	2	14	8	
Partial 1/5 to ½* present	6	0	0	1
Off-less than 1/5 present	13	0	0	1

*No trees had greater than ½ and less than 4/5 bark.

Nest Hole Size

The entrance hole to 28 cavity nests was measured (Table 25). Excavators make a fairly consistent size hole. Although the height and width of flicker holes varied, the area was fairly consistent. We believe that the hole size and shape can be used to identify the excavator with a fair degree of accuracy. This would only hold true during the season excavated because holes may be enlarged by later occupants. Even so-called non-excavators appear to alter a nest hole entrance. Williamson's sapsucker Nest Number 18 was excavated in 1974 and used in 1975 by western bluebirds (Nest Number 27). The sapsucker nest hole entrance increased in area by 26 percent after use by nesting bluebirds.

TABLE 25

TABLE MEASUREMENTS OF ENTRANCE HOLE SIZES TO CAVITY NESTS

Species	Nest No.	w (in)	h (in)	width (in.) mean	height (in.) mean	Excavator
Sparrow hawk	58	2.8	3.9	2.8		
		3	3			
Com. Flicker	21	2.8	2.8			X
	25	2.6	2.7			
	14	2.0	3.5			
	3	2.6	3.0			
	51	2.9	2.7			
				2.8	2.9	
Pileated W.P.				3.8	4.7	X
Yellow-bellied sapsucker	54	1.5	1.5			X
		1.5	1.5			
Wm. Sapsucker	27	1.4	1.4			X
	43	1.4	1.6			
	18	1.5	1.5			
	7	1.5	1.6			
	66	1.5	1.6			
	8	1.6	1.8	1.5	1.6	
Hairy W.P.	4	1.8	1.8			X
	7	1.8	1.8			
	37	1.8	1.8	1.8	1.8	
Black-backed 3-toed	6	1.7	1.8			X
	61	1.9	1.9	1.8	1.9	
Northern 3-toed	57	1.6	1.5			X
	48	1.6	1.5	1.6	1.5	
		1.8	1.8			
Mt. Chickadee	41	1.5	2.8			
	36	2.0	1.8	1.8	2.3	
		1.8	1.8			
Red-breasted Nuthatch	21	1.2	1.1	1.2	1.1	X
Western Bluebird	8	2.3	1.7			
	27	1.6	1.8			
	34	1.9	1.9	1.9	1.8	
Mt. Bluebird	53	1.8	1.4			
	38	2.4	2.3	2.1	1.9	
Desolation Butte		2.5	2.0			

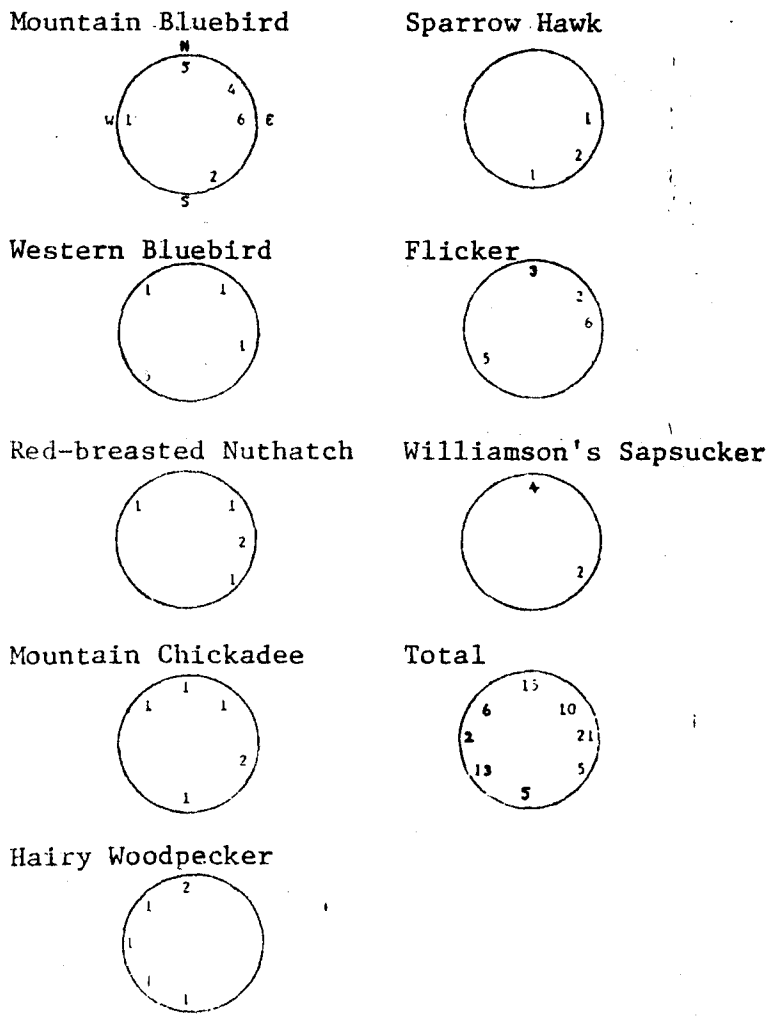
Since cavity nesters which do not excavate their own holes are largely dependent on nest cavity excavators, it is important to know which species provide holes for these non-excavators. A major factor would be the size of the entrance hole. One might expect that a minimum size entrance hole for the species, such as the western bluebird use of the Williamson's sapsucker hole mentioned above, would be a selective advantage against predation by larger mammals or birds and in competing for nest holes with larger birds. Smaller entrance holes should also maintain a more constant nest cavity environment. However, in the case of western bluebirds, we observed them having difficulty entering two different former Williamson's sapsucker holes. The diameter of the hole usually used in bird houses built for bluebirds is 1.5 inches, which exceeds some Williamson's sapsucker nest holes. Most bluebirds used nest holes much larger than 1.5 inches diameter.

The shape of cavity nest holes differed between some species. Williamson's sapsuckers either constructed a round hole or one that was .2 to .3 centimeters taller than wide, while northern 3-toed nest holes were round or wider than tall. The one Lewis woodpecker nest hole in our sample was distinctly wider than tall, although Bent (1939) reported the hole of this species to be perfectly round.

Aspect of Holes

The aspect of the nest hole varied by species (Figure 1).

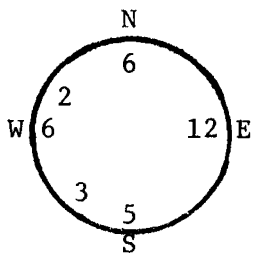
Figure 1 - Aspect of nest holes by species.



Aspect of slope and position on slope

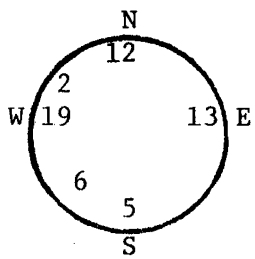
Figure 2 - Distribution of nests according to aspect of slope

Moderate and Steep Slopes



Total 34

All Slopes



Total 57

All Williamson's sapsucker nests were located on flat ground or gentle slopes within 100 feet of a steep downslope.

A number of nests were located on the top near a steep downslope or a short way down the slope. Besides Williamson's sapsucker, this was especially true of flickers, bluebirds and sparrow hawks.

Origin of Nest Holes

Although many non-excavating cavity nesters used cavities made by nest excavators, some on occasion, used holes created by other means such as natural breakage and/or decay. One nest was found in an old pileated woodpecker feeding excavation. It must be understood that some birds referred to as non-excavators can excavate in very soft material.

Diameter at Nest Height (dnh)

The diameter of some trees at the nest entrance hole was measured (Table 26).

Cavities of two nests were measured. These measurements seem to be fairly consistent with those reported by Bent (1939), although it is sometimes difficult to interpret exactly what was measured (Table 27). He reported only average diameters for hairy woodpeckers. The diameters for black-backed 3-toed woodpeckers were similar to the larger diameter listed earlier so perhaps this shape hole is not consistent.

Dividing the difference between the largest diameter and dnh by two gives an estimate of the amount of tree left outside the cavity at the cavity's widest area if the cavities in these smaller trees were the same size as the two measured.

TABLE 26

Tree diameter at the nest hole.

Species	dnh (in.)
Flicker	13.0
	24.2
Williamson sapsucker	29.2
	13.6
	14.9
Hairy woodpecker	6.8
	16.9
Black-backed 3-toed w.p.	9.5
	6.7
Northern 3-toed w.p.	7.0
	9.8
Mtn. Chickadee	10.9
Red-breasted nuthatch	13.5

TABLE 27

Cavity size and shape.

	Hairy Woodpecker	Black-backed 3-toed Woodpecker
Shape of Cavity	Approximately Cylindrical	Straight vertical walls
	Horizontal X-Section	Horizontal X-Section
	Vertical X-Section	
Depth from bottom of entrance hole to bottom of cavity (in.)	6.5	9.1
Horizontal dimensions inside cavity at largest place (in.)	4.5 x 4.8	2.9 x 4.4
Smallest dnh measured for species (Table 26) (in.)	6.8	6.7
Difference between largest horizontal dimension of cavity and smallest dnh (in.)	6.8-4.8=2	6.7-4.4=2.3

All Williamson's sapsucker nests were located on flat ground or gentle slopes within 100 feet of a steep downslope.

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Difference between largest horizontal dimension of cavity and smallest dnh (in.)	6.8-4.8=2	6.7-4.4=2.3

Double Nest Trees

Some trees were located which contained two active cavity nests in 1975 (Table 28).

TABLE 28

Nest trees containing two nests.

Species of Tree	Tree DBH(in)	Tree Ht(ft)	Description	Species of Bird	Estimated Snag Density	Known contai nest p vious
GF	41	33	dead, broken top; xylem very soft. 9 cavities; all bark present	Flicker Yellowbellied Sapsucker (also red squirrel)	5/acre	
PP	25	60	live, flat top tree; dying top branches; 2 nests very close together	Flicker Mt. Bluebird	.2/acre	
PP	39	78	lightning scar; many holes in xylem, live tree	Wm's Sapsucker W. Bluebird	.8/acre	X
DF	15	12	dead, broken top	Wm's Sapsucker Mt. Bluebird	3/acre	X
Green reported two trees with two active nests in 1974.						
PP	37	61	Barkless, many long branches; many cavities	Red-breasted nuthatch, Mt. Bluebird		
PP	23	34	broken off with many branches & bark	Flicker Mt. Bluebird		

Closest Distance Between Nests of Same Species Used at the Same Time

The closest flicker nests were 765 feet apart. This is approximately the distance between three sets of flicker nests from three years on two territorial units reported by Lawrence (1967). These territorial units were approximately 40 acres each. The previous year, 1974, there was an active flicker nest approximately half way between these two nests used in 1975. The closest mountain bluebird nests were 541 feet apart.

Reuse of Nest Holes and Nest Trees

In order to calculate the number of snags needed, an understanding of reuse and loss of nest trees and holes is needed. Trees with active nests in 1974 were checked periodically in 1975 (Table 17). Two out of 29 (7%) trees had fallen down. Sides or tops fell away from three (10%) making the 1974 nest site unusable. Two of these probably have no suitable area for nesting left, the other may at some future date. Trees were also lost due to human activity.

Forty-one percent of the trees used in 1974 which were available in 1975 were used in 1975. Further breakdown of use is given below Table 17. In addition, of ten nests used by cavity excavators in 1974 which were intact in 1975, two (20%) were used by non-excavators in 1975.

Because of damage, we could look into three 1974 holes. All three had been used by mammals after bird use. A tree containing a black-backed 3-toed woodpecker nest in 1975 was cut down during salvage operations later in the summer. On August 27, it contained a deer mouse (Peromyscus maniculatus) and an abundance of mouse nesting material.

The Western bluebird in the tree containing Williamson's sapsucker nest number 43 was using a hole larger than a sapsucker's although there were many sapsucker holes in this tree.

Use of More Than One Snag at Nesting Site

Another snag or snags near the nest tree was found useful in different ways during nesting. Bluebirds used snags close to the nest for a perch when approaching and leaving the nest. This made the parent birds and location of their nest less noticeable - a protective feature. In one case, a snag 125 feet from a nest snag was used by mountain bluebirds as a perch between the feeding and nesting area. The following year, this perch snag was used for nesting.

We watched what appeared to be the first flicker to fledge from a nest high in a tamarack as it flew to a nearby partly dead tamarack. The nest tree and the tree this fledgling flew to towered over dense canopy of secondary growth. This tree lacked many branches and therefore was easy for the fledgling to land on. The parents also used this tree and several others nearby for perching and feeding.

A pair of snags relatively close together appear to be more favorable for nesting sparrow hawks than solitary snags. One sparrow hawk nest tree, which was used successfully in both 1974 and 1975 with five fledglings both years, was located 112 feet downslope from an equal-sized snag. Both snags were ponderosa pine and both had long robust horizontal branches. On July 29, 1974, we observed all five young; one was in the nest hold, two on horizontal branches of nest snag (male and female) and two on horizontal branches of the upper snag (male and female). The latter two were

more advanced in physical development (Hawks start incubating before all eggs are laid so the birds hatch out at different times.) Most of the time the young were on different branches. We watched a parent bring a small bird to the female on the lower nest snag which promptly plucked feathers from this prey. However, before the feathers were completely removed, the young male on the same snag hopped on the branch beside his sister and snatched the food from her and ate it. With this type of competition for food, the younger siblings probably have a better chance of surviving if older siblings have an adjacent snag to move to. On August 9, we found six and possibly seven birds near the nest snags using the same perch trees used by the adults on July 29. These included one snag, one live tree, and four partly dead trees (three of which had dead terminal leaders) used for perching.

Competition for Nest Sites

Competition for nest sites was observed. The most extreme case was a pair each of flickers, mountain bluebirds and western bluebirds, all competing for one cavity for about a week. The flicker had already started nesting and continued to do so.

Mammals move into a number of these holes as reported above. In 1975, a flicker pair excavated a hole and started incubating. The next time activity was observed, there was a squirrel adult and young seen. Just enough time had elapsed that the brood could possibly have fledged if the squirrel moved in right away with young and we saw them within a day or two. Other possibilities include nest failure due to other cause or due to squirrel and squirrel moving in after failure. Additional information is included under reuse of nest holes and nest trees and on Table 17.

Starlings were seen occasionally and one seen was nesting. Booth (1952) did not list the starling in his paper on birds of the Blue Mountain Region. Starlings are strong competitors for cavities. Logging increases the chance for influx of these birds.

Use of Clearcuts and Salvage Areas

Bluebirds, red breasted nuthatches and chickadees were found nesting in clearcuts in which some standing trees were left.

The following were found in salvage cuts made the previous year:

Mountain Chickadee
Western and Mountain Bluebirds
Flicker
Both species of 3-toed woodpeckers
Hairy Woodpecker

This topic will be covered more fully in a later report.

Number of Snags and Logs Per Acre

Density of standing and down dead trees (Table 29) were measured in plots which were primarily established in study site stands to assess tree, shrub and herb cover and composition. These plots were 50'x50' except at sites 2, 12 and 15 where 105'x105' plots (¼ acre) were established. Extrapolations made on a per acre basis on Table 29 from counts taken in the smaller sample plots are exaggerated because of the small

sample size. For example, snags and stubs on sites 11, 13 and 16 were probably removed during logging activities while the numerous dead tree components on site 1 suggest an old stand. Extrapolations made from counts on ¼ acre sample plots are probably close to actual occurrence. Densities of standing and down dead trees are related to many factors in the development of the stand such as previous logging history, tree density, age and stage in successional sequence. The variation in Table 29 illustrates the heterogeneity of habitats in the northern Umatilla National Forest.

On Table 16, the estimated number of snags/acre at the nest site were listed. The dbh of nest trees was generally lower than the average dbh of the adjacent snags in places where the number of snags/acre was less than five. We interpret this as an indication that in areas with less than five snags/acre cavity excavators are forced to use smaller trees than they normally would in order to find a tree that has other characteristics which they require.

TABLE 29

Density of standing and down dead trees on 16 study sites.

Site No.	Stand Logging History	Habitat Type	Snags/acre >8"dbh>20'	Stub/acre >8"dbh<20'	Whip/acre <8"dbh	Log/acre >8"dbh	Live trees/acre >6' ht.
1	None*	Sub-alpine-Big Huck.	115	119	204	170	182
2	None*	White Fir-Big Huck.	12	No count	24	No count	88**
3	None	Pond.P.-DougFir-Kinnikk	17	51	68	0	663
4	None	White Fir-Twin Flower	0	17	0	17	238
5	None	White Fir-Twin Flower	51	17	85	127	580
6	None	Sub-alpine Fir-Big Huck.	34	34	51	119	357
7	None	LodgepolePine-Big Huck.	68	17	0	17	511
8	Select Cut,30-40 yrs.ago	White Fir-Big Huck.	51	289	0	221	459
9	Select Cut,30-40 yrs.ago	White Fir-Twin Flower	34	34	204	153	731
10	Select Cut*	White Fir-Big Huck.	17	17	0	92	187
11	Select Cut*	Sub-alpineFir-Big Huck.	0	0	153	[illegible]	120
12	Select Cut*	White Fir-Big Huck.	4	20	0	40	96
13	Select Cut	White Fir-Big Huck.	0	0	306	102	442
14	Select Cut	Mixed Conifer-Pinegrass	17	17	0	85	221
15	Select Cut	Pond.P.-DougFir-Snowberry	8	4	0	24	120
16	Select Cut	White Fir-Big Huck.	0	0	85	51	561

* Old aged stand
** 48 trees >19" dbh/acre, largest tree 36" dbh.

SUMMARY OF RESULTS

1. Snags are standing dead trees. Partly dead trees, deformed and diseased trees and snags are used by animals for many different purposes.

2. Data from our study presented here are limited to:

   a. Cavity nesting by birds
   b. Two nesting seasons
   c. Thirteen bird species. At least 13 other cavity-nesting bird species nest in the Blue Mountains.

3. Seventy percent of the nests were found in dead trees, 18 percent in partly dead trees and 12 percent in trees with no external dead parts.

4. Live nest trees (no external dead parts) averaged 15 inches dbh (maximum size 26 inches dbh); often were tamarck; and had decay and/or hollow areas in the wood.

5. Hairy woodpeckers characteristically mostly used live trees - either ones with decayed heartwood or ones with dead tops in which they excavated near the junction of dead and live parts. Three-toed woodpeckers used live or recently dead trees. Other species usually or always used dead trees.

6. Ninety-nine percent of the trees used had at least one noticeable defect or signs of defect.

7. Defects or signs of defects included:

   a. broken tops
   b. dead tops
   c. multiple leaders
   d. lightning scars
   e. frost or drought cracks
   f. flat tops - ponderosa pine
   g. clustered branches - Tamarack (esp. live trees)
   h. Echinodontium tinctorium conk - true firs, 3-toed woodpeckers

8. Ninety-one percent of the dead nest trees had a broken top. Fifty-seven percent of a sample of snags had broken tops.

9. Ponderosa pine was generally preferred, but some individual species selection was noted. Three-toed woodpeckers selected true firs and red-breasted nuthatches selected Douglas fir.

10. Tree species used were in general, those species in a habitat which would be the older trees in the succession. In ponderosa pine-Douglas fir habitat types, 64% of the nests were in ponderosa pine and 36% in Douglas fir; in grand fir and mixed conifer, 10% were in ponderosa pine, 26% in Douglas fir, 39% in grand fir, 19% in tamarack, 3% in subalpine fir and 3% in aspen. In subalpine fir habitat types, 71% of the nests were in tamarack, 14% in subalpine fir and 14% in spruce.

11. The mean dbh of nest trees was 21.5 inches. Forty-eight percent were in trees 20 inches or larger. Seventy-five percent of the nests were in trees with a dbh 13 inches or more.

12. Use of smaller dbh trees was higher in areas with smaller numbers of suitable trees such as salvage cuts, fuel breaks, harvest areas.

13. In general, trees with larger dbh were selected by birds. An exception was the 3-toed woodpeckers.

14. Some trees had multiple nest holes. These were often of different species of birds. Trees with multiple holes were generally large in dbh and height. The mean dbh of trees with two or three holes was 20 inches and the mean height 34 feet. Ones with four or more holes had a mean dbh of 36 inches and a mean of 43 feet in height.

15. Trees that contained two active nests at the same time were generally large trees (average dbh 30 inches, average height 46 feet).

16. Mean height of the nest trees was 39 feet. Seventy-five percent of the nests were in trees 20 feet or more. Thirty-one percent were in trees 50 feet or more.

17. There is a pattern in the height of nesting of each species of bird.

18. There seems to be a general consistency in the ratio $\frac{\text{nest height}}{\text{tree height}}$.

19. The entrance of 32 percent of the nests was within two feet of the top of the tree. This was especially true of nests in shorter nest trees.

20. Three of 64 cavity nest trees were within five chains of water. Data was insufficient to illustrate any positive relationship.

21. All Douglas fir and grand fir nest snags had 4/5 or more bark present; 61 percent of the ponderosa pine nest snags had less than 1/5 bark present; and 90 percent had 1/2 or less present.

22. Bluebirds used holes as small as Williamson's sapsucker holes but seemed to prefer something larger.

23. It is important to consider which excavators provide holes for which species of non-excavators.

24. A number of nests were located on the top near a steep slope or a short way down the slope, especially Williamson's sapsucker, bluebirds, sparrow hawks and flickers.

25. Some secondary nesters used cavities formed in trees by disease and/or accident or feeding activities of birds.

26. The diameter of the tree at the cavity must be great enough to contain the cavity and still provide sufficient wood and bark around the nest hole. Some factors related to what is sufficient wood and bark is protection from predators and weather and temperature equilibrium. There are probably a number of factors related to cavity size requirements for various species.

27. Seven percent of the nest trees found used in 1974 had fallen by the 1975 nesting season. Ten percent were unusable because of breakage. Therefore, 17 percent were lost because of natural events.

28. Of trees used in 1974 which were available in 1975, 41 percent were re-used. Thirty-two percent of those available were used by the same species, and 18 percent by a different species. Some trees had multiple use.

29. Of holes used in 1974 which were available in 1975, 32 percent were re-used. Twenty-three percent of those available were used by the same species and nine percent by a different species.

30. Woodpeckers did not use a hole two years in a row.

31. Of ten cavities used by primary nesters in 1974, two (20%) were used in 1975 by secondary nesters.

32. Mammals readily used nest cavities.

33. A dead tree near a nest tree is used frequently by some species when nesting.

34. Areas with less than five snags/acre may exert stress on cavity nesters.

35. Starlings are moving in to the Blue Mountains. These birds are strong competitors for cavities. Even without starlings, there is competition for holes between primary and secondary cavity nesters and mammals.

36. Substandard nesting conditions can result in greater vulnerability to predation, disease, parasites, accident and lower reproductive success.

37. If some trees with holes are left in clearcuts, bluebirds and some other species will nest there. If some dead or dying trees are left in salvage areas, a number of cavity nesters will use these areas. If stubs with decaying heartwood are left in fuel breaks, cavity nesters will use these areas to a small extent.

Discussion

It must be kept in mind that what has been reported here has only been in connection with cavity nesting and does not cover any of the other many uses of snags, dying and deformed trees. It must also be remembered that there are a number of cavity nesters for which we have presented no data (Table 30), but which are nesting birds in the Blue Mountains.

Care must be taken in assessing information on what an animal has been found to use. For example, just because a bird is found using a particular tree, does not mean this is what is optimal or even sufficient. Lack of some essential component will either force an animal into using a substitute, curtailing the associated activity and/or dying. Unsuitable habitats or components of a habitat produce more subtle results, such as greater vulnerability to predation, disease, parasites, accident and lower reproductive success. To be able to determine how far a population can be pushed before it declines is very difficult. The effect of the lack or low amount of some components in their environment can be measured in some cases. However, to predict synergistic effects of several subminimal or even suboptimal habitat needs, especially in the face of dynamic environmental conditions is much more complex. Add to this the needs of animals that we aren't even aware of or understand.

More than 30 percent of the nests found were in "recently disturbed" (less than five years since disturbance) sites and more than 20 percent were in what was classified as "deprived" sites in regard to number of snags. Some effects on use have been shown.

TABLE 30

Summer and permanent residents identified by us which are cavity nesters and are not on Table 7:

Great Horned Owl
Vaux's Swift
Pileated Woodpecker
Downy Woodpecker
White-headed Woodpecker
Violet-green Swallow
Chestnut-backed Chickadee
White-breasted Nuthatch
Pygmy Nuthatch
Brown Creeper (especially under loose bark)
House Wren
Winter Wren
Starling

Cavity nesters not observed:

Screech Owl
Pygmy Owl
Saw-whet Owl

In looking at cavity nesters, we see a wide range of diameter of trees used by some species. Is there any detrimental effects if a bird uses some size as opposed to others? What about height of nest? There seems to be some pattern to the height often used by a species. Is there some survival value to this behavior?

Some possible reasons for or effects of:

I. Nesting height

A. Protection from predators

1. If higher, harder to get to or detect

a. Climbing in-ex. snakes
b. Ripping in-ex. bears

2. Some positions may be more susceptible to avian predation

a. On adults
b. On young when leaning out of hole

B. Competition with other birds and mammals for hole

C. Flight pattern of species

D. More likely to find proper conditions for hole at certain height

1. Better excavating conditions
2. Natural breakage, holes and/or decay

E. Wind patterns

F. Degree of light (Lawrence 1966)

G. Degree of cover for approach

H. Survival of young when fledging

II. Larger dbh trees used more often in relation to abundance

A. Big trees may stand longer and don't decay as rapidly (Wright and Harvey 1967)

B. The bigger the tree, the more species available to use it (Thomas, 1975)

C. More places on the tree suitable for drilling

1. More area
2. Greater variety of conditions at any one time

D. More tree left surrounding the cavity

1. Temperature equilibrium easier to maintain
2. Less ease for predators to rip into nest. Many reports in literature of attempts by predators.
3. Certain size cavity may be optimum

a. Too small, there may be problems with young as they get very aggressive.

b. Too small, maneuverability for adults difficult so less efficient when feeding young inside and turn around to come out.

c. If heartwood only decayed, tree must be certain size and age for large enough diameter heartwood.

E. Can nest be higher and still have nest at place of large diameter

Some possible reason(s) for:

I. Ratio of nest height to tree height

A. Pattern of decay for area related to:

1. Moisture
2. Temperature
3. Types of decaying organism
4. Species of trees

II. Many birds nesting within two feet of top

A. Pattern of decay esp. flickers, not good excavators (trees break off where decay greater)

B. Light (Lawrence 1967)

C. Bird prefers to nest higher but that is all the higher they can get

DBH, Nest Height and Tree Height

It is evident that larger trees more often fill the requirements of cavity nesters, although a substantial amount of nesting does occur in the 10-19 inch dbh class. There may be a number of different reasons for this as outlined above. Birds, except the 3-toeds, frequently used the smaller dbh trees in "deprived" sites. Multiple hole trees were larger in general as were trees with two nests active at one time.

In Table 27, it can be seen that in the smallest dbh measured for two species that the cavity size in these trees would either have to be reduced or the cavity would be within approximately one inch of the outside. Nests in this situation may have two strikes against them. The bark and wood would be relatively easy to rip through and the insulating properties may not be sufficient to maintain a temperature equilibrium. Lawrence (1967) found that during cooler weather, young were brooded more and for a greater number of days. This leaves less time for food gathering. There is probably a certain thickness of wood (and bark) which provides good insulation. Increase over this amount probably would not add much to obtaining an equilibrium. However, we do not know what this thickness for temperature equilibrium is. Some forms of decay reduce the insulating qualities of wood.

Reasons for Selecting Larger DBH and Taller Trees for Retention

It is not necessary to plan for as many replacement snags because bigger trees:

1. Don't decay as fast, so longer lasting
2. Have more places for holes
3. Are suitable for more species of birds
4. When upper sections break off, provide large down logs which are needed
5. Help fulfill other uses of snags (to be written about in a later report)
6. Provide various heights for cavities
7. Tend to be more wind firm

Decay

A tree doesn't decay at a uniform rate all over. Differential decay is due to:

1. Area of entrance of decay organisms
2. Variations of temperature and moisture; for instance, conditions undesirable for decay

    A. Cool and wet - such as found at base
    B. Hot and dry - such as found at top

3. Wood with wide annual rings decays faster

Thinking about A. and B. under 2., one can get a picture of broken tops being produced by a more rapid decay below the top. Wright and Harvey (1967) give a good picture of progression of decay in beetle-killed Douglas-fir. This paper should be read by anyone interested in snags.

Different textures of decayed wood are produced depending on decay organisms present. Some of these are useful to cavity nesters and some are not.

A tree that decays in the heartwood with the sapwood intact, provides a more secure nest. One way this may occur is in a tree which is still alive but decay has entered the heartwood through injury.

There may be a limit to how far various species will excavate through sound wood to reach decayed wood.

Reuse of Holes

No woodpeckers used the same hole two years in a row. In two cases, a flicker nest was found in 1975 near a 1974 nesting site. Reuse of old holes by flickers occurred, as some used holes which were obviously old. It is not known how many years elapse before a flicker reuses a hole. Lawrence (1967) and others report that territories of woodpeckers remain fairly stable year after year even if different individuals use the area. There is a tendency for the same birds to use the area unless there is mortality. There is probably selection against using the same hole two years in a row because of parasites, disease and predators. Also holes may be taken over by other birds and mammals.

Suitability of holes for secondary nesters may depend on many factors such as:

1. Size of entrance
2. Size of passage
3. Depth
4. Size and shape of actual nest area
5. Location on tree
6. Habitat type, degree of openness, age of stand
7. Directionality
8. Location of feeding area
9. Presence of parasites

They also have to contend with competition from other birds, mammals and insects.

Although bluebirds use sapsucker holes, they more often use a larger hole. Erskine and McClaren (1972) reported mountain bluebirds using flicker holes instead of sapsucker holes. Size and shape of passage and hole relate to maneuverability and behavior of adults and young. Too large a nest area may be detrimental to incubation. A paper on chickadee nesting (Kluyver, 1961) reported much lower hatching in a nest which was in a floor space larger than the nest. The sides of the nest gave way; the eggs frequently spread out further and were not incubated properly. Location on the tree, direction of hole, aspect of site and amount of wood surrounding hole may relate to temperature in the nest. Some of the implications of this were discussed previously. The timing of nesting by different species may call for different requirements. Early nesters may need heat while late nesters may need insulation from heat. The mountain bluebird showed a use of holes facing North, Northeast, East and Southeast. Since they nest in open areas which are often on the warmer aspects (except in cuts), perhaps escape from heat is the ultimate factor in this selection.

Some secondary nesters can excavate in very soft wood. Nests in very soft wood are quite vulnerable to predators which rip the nests open as reported by many others, for instance-Kilham (1968, 1971) and Erskine and McLaren (1972). They also use natural cavities. Some of these are quite shallow and more accessible. Others in trees with a well decayed interior are very well protected.

An understanding of which primary nesters provide holes for which secondary cavity nesters is needed to properly plan for the continuation of these species. Another factor is rate of reuse of holes by these birds. In our small sample, we found a rate of reuse by the same species of 23% and by a different species of 9%. This was a reuse rate of 32% of holes still available which had been used the previous year. This is surprisingly high.

Species of Trees

The species of tree used very often reflected which species were the older ones in the stand.

The predominant selection of ponderosa pine may be related to a number of different factors as follows:

A. Length of period standing
B. Earlier trees in stand so older sooner
C. Types of decay organisms which attack it
D. Pattern of decay
E. Characteristics of the wood or shape of tree

MANAGEMENT IMPLICATIONS

Guide to selection of trees to leave for cavity nesters. (For use in situations where it is necessary because of other considerations to cut snags or potential snags.)

I. Trees for immediate or near future use by cavity nesters.

A variety of characteristics are given. Care must be taken to avoid getting a set picture of just one or a few of these characteristics in your mind and always leaving the same types. A variety is much more important. Different characteristics are important for various species of birds. For further information, tables are listed.

A. Broken tops - broken tops may be due to decay or decay may enter because of the broken top. (Figure 3) (Table 5, 6)

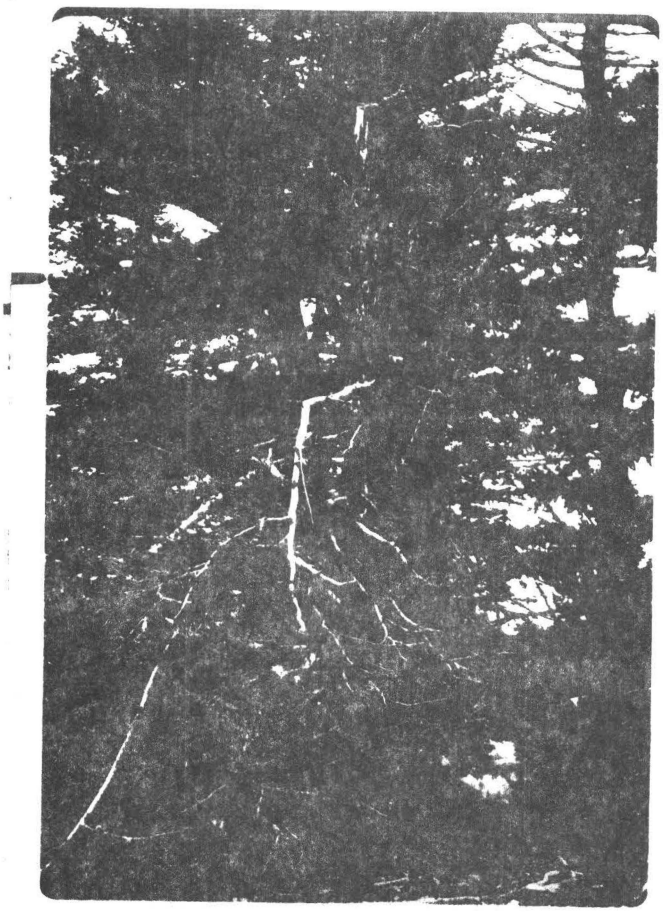

Figure 3 - Well used broken top snag

B. Double tops, etc. (Table 5)

C. Dead top (Figure 4) (Table 5)

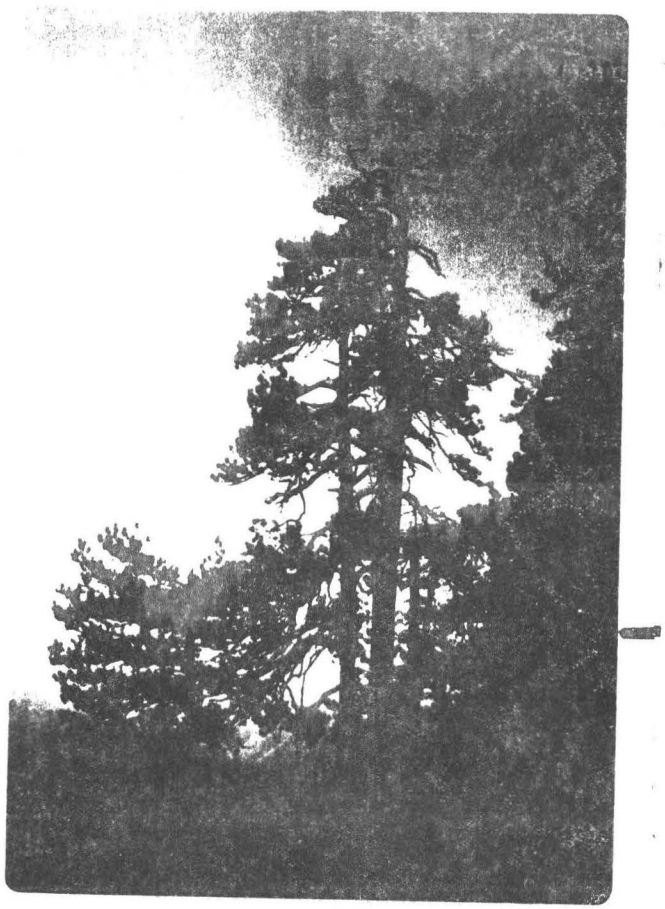

Figure 4 - Dead top tree

Birds often excavate in the approximate area where live tree and dead tree meet. Since the dnh (diameter nest height) has to be large enough to accommodate a cavity, these cannot be small, ash trees. [illegible] of snag-topped trees with cavities in the upper part was [illegible]. Secondary nesters later use these holes. If the diameter of the tree is large enough, the secondary nesters can also use cavity formed by breakage.

D. Lightning strike (Figure 5) (Table 5); the more wood exposed, the better for cavity nester use.

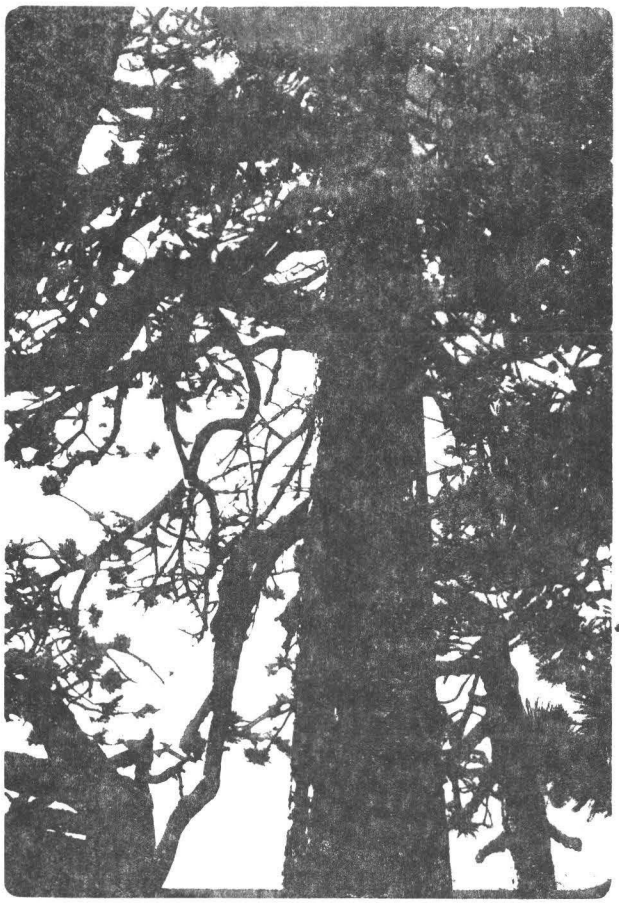

Figure 5 - Lightning struck live tree

E. Frost or drought crack (Figure 6) (Table 5)

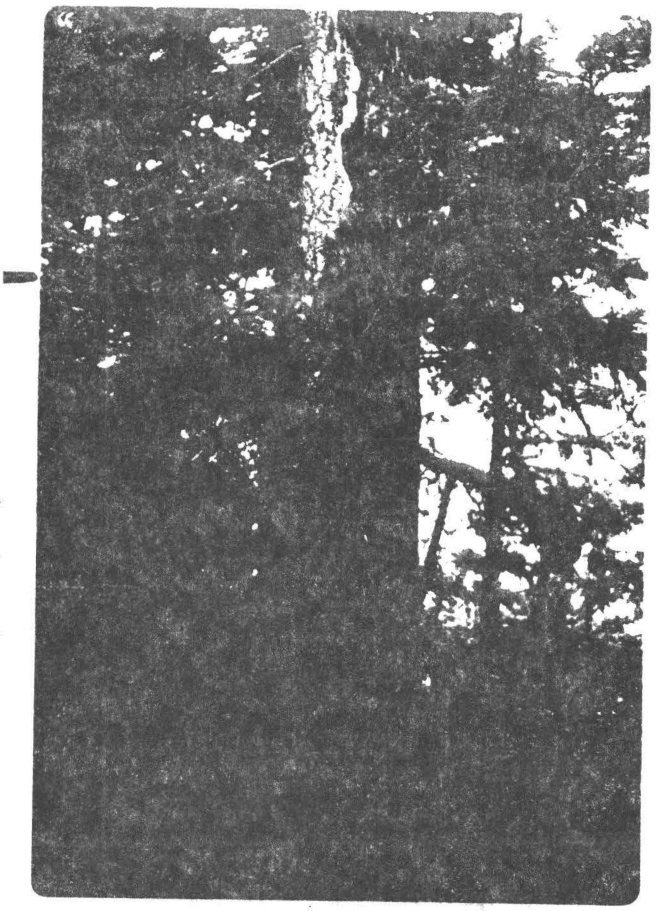

Figure 6 - Crack provides potential nest habitat for secondary nesters.

F. Live trees with evidence of heartwood decay

G. Larger dbh trees (Table 12, 14, 18)

H. Taller trees (Table 14, 19)

I. Tree with apparent nest holes, especially ones with multiple holes (Table 17, 18, 19)

1. Important for secondary cavity nesters especially for first years after a cut until additional holes are excavated by primary nesters. Balda (1975) estimated 268 holes/100 acres needed each nesting season in Arizona.

2. May indicate sapsucker nesting tree (see Table 25 for hole size)

3. Primary nesters may reuse holes present

4. Primary nesters may excavate new holes

J. Trees located at or near breaks

K. Near water - aspen and black cottonwood, if present

L. Large trees with loose bark

M. Characteristics indicated under section which follows entitled "Long and Short Term Considerations".

N. Ponderosa pine

1. In many cases, the preferred species (Table 11)

2. Greater than 50% bark off (Table 24) except trees left for pileated woodpeckers

3. Flat top - dead or alive (Table 5)

4. Pileated woodpecker - greater than 50 percent bark on, greater than 20" dbh - preferably a mean of 30" and greater than 30 ft. high, preferably more than 40 feet (Figure 7) (Bull 1975)

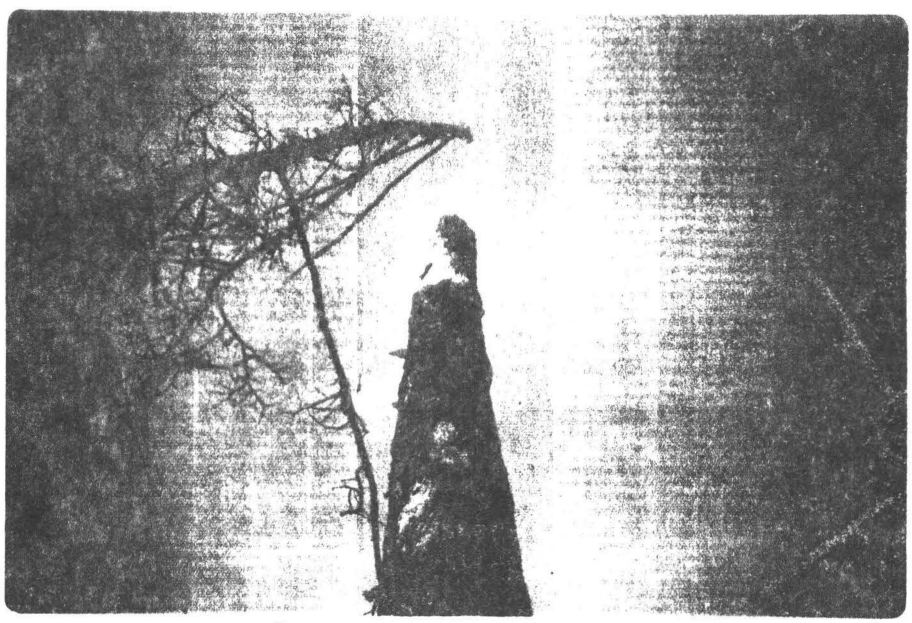

Figure 7 - This snag is a good potential pileated nest tree. In actual circumstances, the stand is too open to provide desirable pileated nest habitat. Note flicker center, left.

5. Sparrow hawk - thick, horizontal branches, dead tree on sparsely stocked sites. (Figure 8) Several snags within several hundred feet on upper part of slopes, particularly near top.

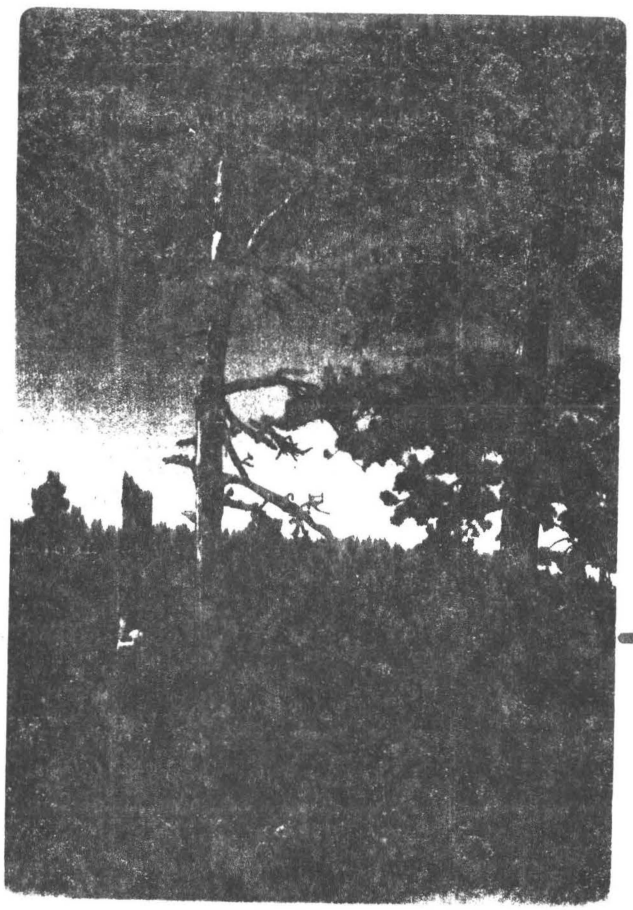

Figure 8 - Center tree is a good potential sparrow hawk nest snag.

O. Tamarack

1. Clustered branches - dead or alive (Figure 9 and 10) (Table 5)

Figure 9 - Dead top live tamarack provides good nest potential.

2. Yellow-bellied sapsucker - dead tree with more normally placed branches broken off to 2-10 inch stubs. (drumming tree)

3. Pileated woodpecker - see I-L-3

4. May be equal to ponderosa in importance

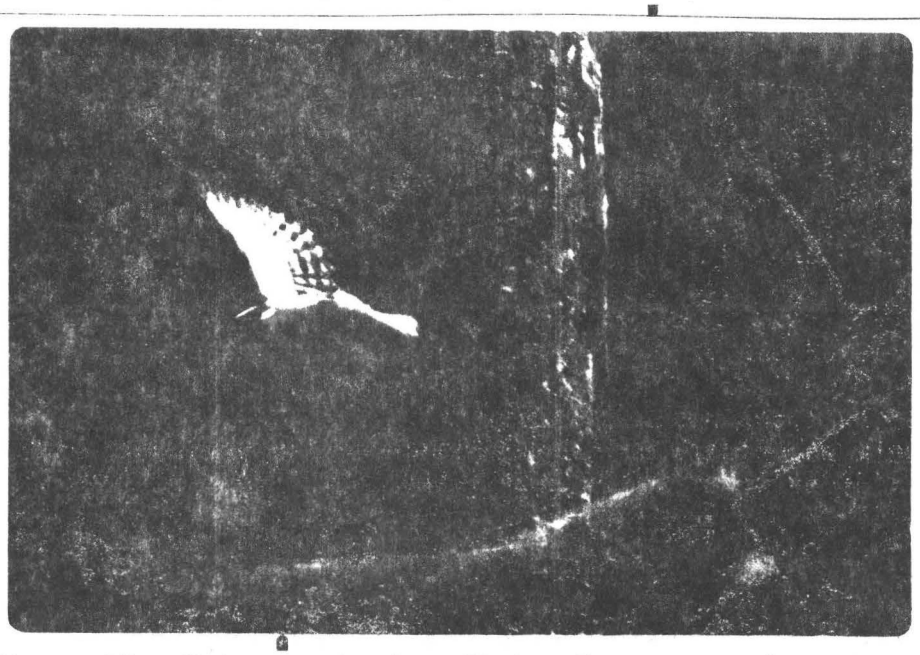

Figure 10 - Hairy woodpecker flying from tamarack nest cavity.

P. Grand fir

1. Large dbh (25-35 inches or more) dead top live trees
2. Large dead trees - greater than 25-36 dbh
3. 3-toed woodpeckers, 10"-16" dbh live or recently dead trees with Echinodontium tinctorium conk eight to 25 feet from ground (also subalpine fir).

Q. Douglas fir

1. Bark on (Table 24)
2. Red-breasted nuthatch - very soft wood, bark on, dead tree

R. Trees irregularly spaced, some close, some far apart but same number/every few acres

S. A mixture of hard and soft snags

T. For approximate percentages of tree species in each habitat type, see lower part of Table 11.

U. Guidelines can be laid down but it takes good judgement with some background of understanding by the people on the ground to make them work.

II. Trees for future use.

Planning for cavity nesters after the present set of snags fall is more complicated.

A. During later thinning operations, if deformed trees are all taken, there will be less chance of the right kinds of snags developing.

B. In areas of less trees/acre, it must be kept in mind that there are fewer trees that will die in a given period. This would apply in situations such as planning for salvaging dead trees from a ponderosa pine site where there are a few dead trees. The replacement rate is very slow; however, a snag usually lasts a long time.

C. After final cutting, it will be quite some time before any new trees reach a size suitable for any cavity nesting. Once the dead trees that were left fall, there will be no nesting trees in these sites unless some live trees are also left. There are several stages of live trees that need to be planned for which are listed below in order of use according to time.

1. Large partly dead trees
2. Large live trees
3. Smaller or long lived trees for use in fifty years or more

D. With present plans for shorter rotation, there will be no big, old trees without plans made for them. These trees receive a high proportion of use.

E. Small trees with broken tops will not grow into large broken top trees.

F. Trees can be selected for early future use using some of the criteria listed under I. with modifications for time. For example, ponderosa pine with bark on or live trees with defects such as tufted branched tamaracks.

G. Characteristics indicated under section entitled "Long and Short Term Considerations".

III. Short and Long Term Considerations

If trees are selected which will last longer, plans for future snags could be less complicated and the number of trees required for future snags could be lower.

A. Select windfirm trees

Trees protected from the wind, such as in the middle of a uniform stand, are not as windfirm after being exposed by cutting or thinning as trees which were in more exposed locations such as:

1. Extending above the canopy
2. Within 50 feet or so of the windward side of a stand
3. In more open situations

Selecting windfirm trees is especially important in areas vulnerable to heavy wind damage such as ridgetops, gaps, saddles, lee slopes, leeward cutting boundaries and areas of high soil moisture.

Tree shapes also play a role in vulnerability to wind. There are good publications concerning windthrow, for example Gratkowski (1956) and Curtis (1943).

B. Select trees with no evidence of root and butt rot. This should not negate leaving some trees in which the entire stem is well decayed, but refers more to the wide range of conditions of trees other than totally decayed. These trees would stand a long time if root or butt rot would not promote windthrow and breakage. Injuries near the base of a tree permit entrance for fungi and carpenter ants. Carpenter ants will move into solid wood. Their presence would cause the tree to be weaker, but since carpenter ants are so important for food for some of the woodpeckers and for feeding their young, it is advisable to keep these trees.

C. A larger (height, diameter) tree provides more locations for cavities and provides a wider range of wood conditions to choose from.

D. Larger trees decay more slowly so will last longer (Wright & Harvey, 1967).

E. Live trees which are deformed or damaged such as with a lightning strike scar or a dead top will last longer than a dead tree because roots are still active and wood and bark will continue to form.

Other Points to Ponder

1. Trees marked for cutting, which then must be cut and are left lying because of heartrot represent a waste of manpower and a loss to wildlife. (Figure 1.) Moreover, some fuels people have expressed the thought that they would prefer culls left standing than cut and left lying.

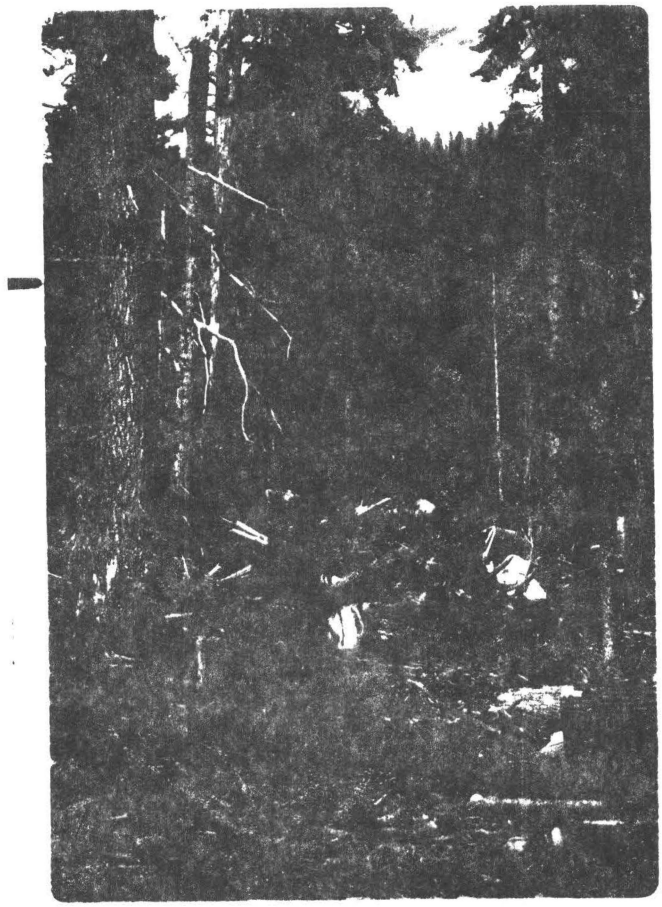

Figure 11 - Cull material left after logging.

2. The practice of only cutting snags when there is a good reason given should prevail instead of only leaving snags when there is a good reason given.

3. Trees with cavities left in clearcuts as opposed to no trees left makes the difference between bluebirds and no bluebirds nesting. This is true in all habitat types. (Figure 12) In addition, other cavity nesters will use trees left also.

Figure 12 - Mountain Bluebird on a hunting perch

4. Trees left with cavities in clearcuts and salvage cuts are important to many cavity nesters. However, cavities in both hard and soft snags may be lost during broadcast burning for even if the tree is left standing, the cavities readily burn out. Holes higher up are less likely to be affected. If the cavities are gone, secondary nesters will not be able to nest for some time.

5. Cavity nesting birds are insect eaters. Areas without nesting opportunities for these birds lose out on having a huge amount of insects destroyed. The question is not "can the forester afford to leave these snags?" but "can the forester afford not to leave them?".

SUGGESTIONS FOR FURTHER STUDY

Activities of man such as thinning and harvesting of trees often result in losses of dead, deformed or dying trees. In order to maintain a population of the various animals using these trees, an understanding of the number and characteristics of trees needed must be gained. To plan for maintaining a supply of these trees after harvest until new growth produces a new round of large enough dying trees, some facts regarding the length of standing and stages and classes of snag condition are needed. What factors produce usable trees? The organisms attacking a tree and the way it is dying produces varied characteristics which relate to the usefulness of the tree to various animals and to its length of standing. In turn, differing conditions relate to which decays affect the tree. Some kinds are useful to cavity users and some are not.

Decisions on a plan of action for an area in relation to cavity nesters must be built on knowledge gained from similar environmental conditions. In other words, from somewhere in the vicinity. For example, the mean height of nest trees in our study was similar to the nest trees reported by Anderson (1974) but different from McClelland in Montana (1974).

At the same time, knowledge from different areas can be used to gain insights into this complex problem. For example, Anderson's ratio of nest trees in hard snags to nest trees in soft snags was quite different from Gale's findings in California (1973). Making some inferences from differences in moisture and the effect on length of standing and rate of decay, one can come up with possible explanations for this difference. Following up these ideas might be illuminating.

Different areas have varying patterns of use depending on:

1. Species of animals present
2. Variations in trees because of
   - a. Weather
     - Humidity
     - Wind
     - Temperature
     - Seasonal patterns
   - b. Species of tree
   - c. Topography
   - d. Kinds of insects, disease and decay

In order to formulate a viable snag policy and put it into use, some questions have to be answered. The following list includes some of the more pressing questions which have to be answered and very briefly some ways to get at the answers. Details will not be included here.

1. How long do snags stand? Probably the fastest way to get answers to this is by use of dendrochronology.

2. What is the rate of loss of trees that are being used by cavity nesters? We obtained a figure on this from a very small sample (Table 17). A follow-up on the nesting trees from 1974 and 1975 in 1976 will produce information from a much larger sample. Different environmental conditions, animal and tree species would probably cause different results in other localities so this kind of data needs to be collected in other areas. This is true of many of these questions listed.

3. What is the rate of reuse of holes and trees by the same and different species? Information on these factors is shown on Table 17. This is just a start of the information needed.

4. When does an increase in the rate of reuse become detrimental? This calls for an intensive study approaching the problem from several different angles.

5. Which species of primary cavity nesters excavate holes for the various secondary cavity nesters. If choices have to be made, which primary nesters need to be maintained at a higher level to provide for certain or all secondary nesters?

    a. Table 17 provides some information. There is some information in the literature on this topic. Follow-up on the 1974 and 1975 nests will provide more information.

    b. Measurements on entrance sizes are provided on Table 25. Other people could use these as an aid for figuring out what species excavated a hole being used by a secondary nester. We can also do the same with more of our nests.

    c. Characteristics of cavities used by secondary nesters need to be assessed in regard to characteristics listed under Reuse of Holes in Discussion. In conjunction with this, cavities produced by primary nesters need to be assessed in relation to the same characteristics.

    d. The mountain bluebird nests we found, with one exception, consistently faced a narrow range of directions. Would additional nests show this? If so, does this pattern show only in this locality? If there is a pattern, then guidelines for trees with holes left after cutting need to incorporate this fact. Temperatures in cavities on different sides of trees need to be measured to determine if there are important differences.

6. What are the factors which produce a "good" snag?

    a. Bull's (1975) torque wrench method of determining hardness (density) could be used as a measurement close to the site of excavation. Also, the species of decay could be determined or at least characteristics of wood texture described and whether sapwood or heartwood or both are affected. Information of this type would provide a better understanding of which trees will be useful and which will not. It may also answer why certain species of trees seem to be preferred and why certain heights for nests are chosen.

    b. Recently dead trees from tussock moth and mountain pine beetle effects, for example, should be marked and followed up as a long term study on the evolution of trees dying from these causes. Subsequent use could be recorded. This could be looked at in terms of low and high snag density and use in relation to use of dead trees in general.

7. What importance is the dbh of the trees? Another crucial question in relation to management is just what difference does the use of trees with different dbh make?

   a. Temperature equilibrium. Temperatures could be monitored in active nests with different thicknesses of surrounding wood.

   b. Size of cavities could be measured in relation to each other for the same species bird, dbh, diameter of heartwood.

8. How many trees/acre are needed? Our approach was discussed under Number of Snags and Logs Per Acre using data on Table 16. This needs to be followed up to see if it is a valid approach.

9. What are the characteristics of trees used for roost holes, feeding and drumming trees?

10. Some of the tussock moth salvage areas had cavity nesters using them one year after cutting. How many years will these same species continue to use these areas?

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